On the relation between age and linear measurements of the Pearl Oyster, *Pinctada vulgaris* (Schumacher), of the Gulf of Kutch

BY

K. R. Narayanan and M. S. Michael

Fisheries Research Station, Government of Gujarat, Jamnagar

(*With four text-figures*)

Introduction

The coral reefs along the northern coast of Jamnagar District, Gujarat State, yield good quantities of Mother of Pearl Oysters. Their systematics have not been worked out in detail so far, but they have been provisionally identified as *Pinctada vulgaris* (Schumacher), which name is used in this paper. Regular pearl fisheries have been conducted in the area and records are available from the year 1913. The authors are not aware of detailed investigations on the oysters from this locality except by Gokhale *et al.* (1954), who studied the age, growth rate and approximate age of pearl formation. In the present study an attempt is made to relate the age of the oysters (as represented by the annual growth rings) with the linear measurements, like length, breadth, hinge length, thickness, and hinge width and to examine the dependability of these measurements in assessing the age of the oysters.

Previous Work

Hornell (1922) found that ' the growth rate of the Indian oysters is distinctly retarded after the third year, the life conditions being more favourable to the young than the old ', and that ' the hinge line is shallow at first but with increasing age, becomes deeper and gutter-like '. ' Its depth and width are our best indications of the age of the oyster '. Cahn (1949) reports that Yamagouchi working on the developmental history of the Japanese Pearl Oyster, *Pinctada martensii* observed that the growth rate is fast up to the fourth year, after which it is retarded. Devanesan & Chidambaram (1956) also observed that the rate of increase in the

measurements is great in the young oysters and decreases with age and that the number of growth rings cannot be accepted as a key for determining the age of the oysters, as ' these concentric curving lines are too closely set in the young and are generally abraded in the adult '. However, Rao (1951) had used such rings in ascertaining the age of *Katelysia opima* (Gmelin). According to him, the rings are ' disturbance rings, caused by the cessation of growth, which may be due to drop of salinity of sea water '. Gokhale *et al.* (1954) found that the rings are formed annually on the shells of the oysters and hence used them as indicators of age of oysters and that the thickness gave more consistent data than other measurements. Though Hornell (1922) had recommended the use of hinge width and hinge depth measurements in aging oysters, these two measurements, it appears, have not been studied by other authors excepting Tranter (1958), who observed that the Australian Pearl Oyster, *Pinctada albina* (Lamarck), attained maturity at a heel depth of 0·5 mm. Alagaraja (1962) studied the length-weight relation of pearl oysters of the Gulf of Mannar but has not indicated the relationship between age and thickness or hinge.

Materials and Methods

The material used is the data on length, breadth, hinge length, hinge width, thickness, and the growth rings of pearl oysters reared in the Pearl Oyster Park and the sea-water tank at Sikka, by the Department of Fisheries, Gujarat State. In addition, measurements of about a thousand oysters collected at random during the survey conducted by the Fisheries Research Station, Government of Gujarat, Jamnagar, in 1964, have also been incorporated.

The authors have followed the terminology, as adopted by Devanesan & Chidambaram (1956) Length is the actual depth of the animal

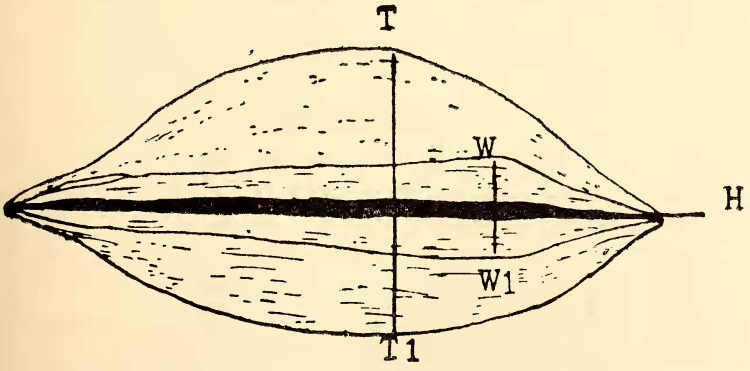

Fig. 1 H : Hinge ; T-T1 ; Thickness ; W-W1 ; Hinge width.

and indicates the longest distance between the hinge line and the outer margin of the valves. Breadth is the maximum distance, along the

antero-posterior axis of the body and corresponds to the actual length of the animal. Thickness, the maximum distance between the external surfaces of the two valves. The hinge length is the actual length of the animal along the hinge line, and the hinge width, the maximum distance between the edges of the two valves at the hinge (Fig. 1).

The measurements, excepting hinge width, were measured with vernier callipers and the hinge width with a pair of dividers. All linear measurements are in millimetres.

Data analysis

The weighed mean of the length, breadth and hinge length of the valves were worked out age-wise and are shown in Table 1.

Table 1

Age in years	Length	Breadth	Hinge length
1	44·05	42·14	38·42
2	61·68	58·93	55·45
3	76·20	67·66	62·00
4	81·62	74·32	66·09
5	85·15	77·35	69·37
6	86·65	80·50	72·44
7	86·67	76·70	69·84

It is apparent from the table that the length, breadth and the hinge length increase with age. The rate of increase is rapid up to the third year, but retarded subsequently and is negligible after the sixth year. This might be due to the lessening of the metabolic rate of the animal with increasing age (Fig. 2). These observations agree generally with those of Hornell (1922), Cahn (1949), Devanesan & Chidambaram (1956) and Gokhale *et al.* (1954). However, Hornell's contention that the lessening of the rate of growth is due to encrustations has not been accepted by Gokhale *et al.* (1954). Our observations support the views of the latter since the oysters studied were periodically checked and cleaned of encrustations at regular intervals.

The thickness and hinge width were correlated with the annual growth rings, as shown in Tables 2 and 3.

As can be seen from Table 4, the age-wise increase in thickness and hinge width are more or less uniform, though not constant (Figs. 4 and 5). There is no retardation in the increase of these measurements at any particular stage, unlike in length, breadth and hinge length.

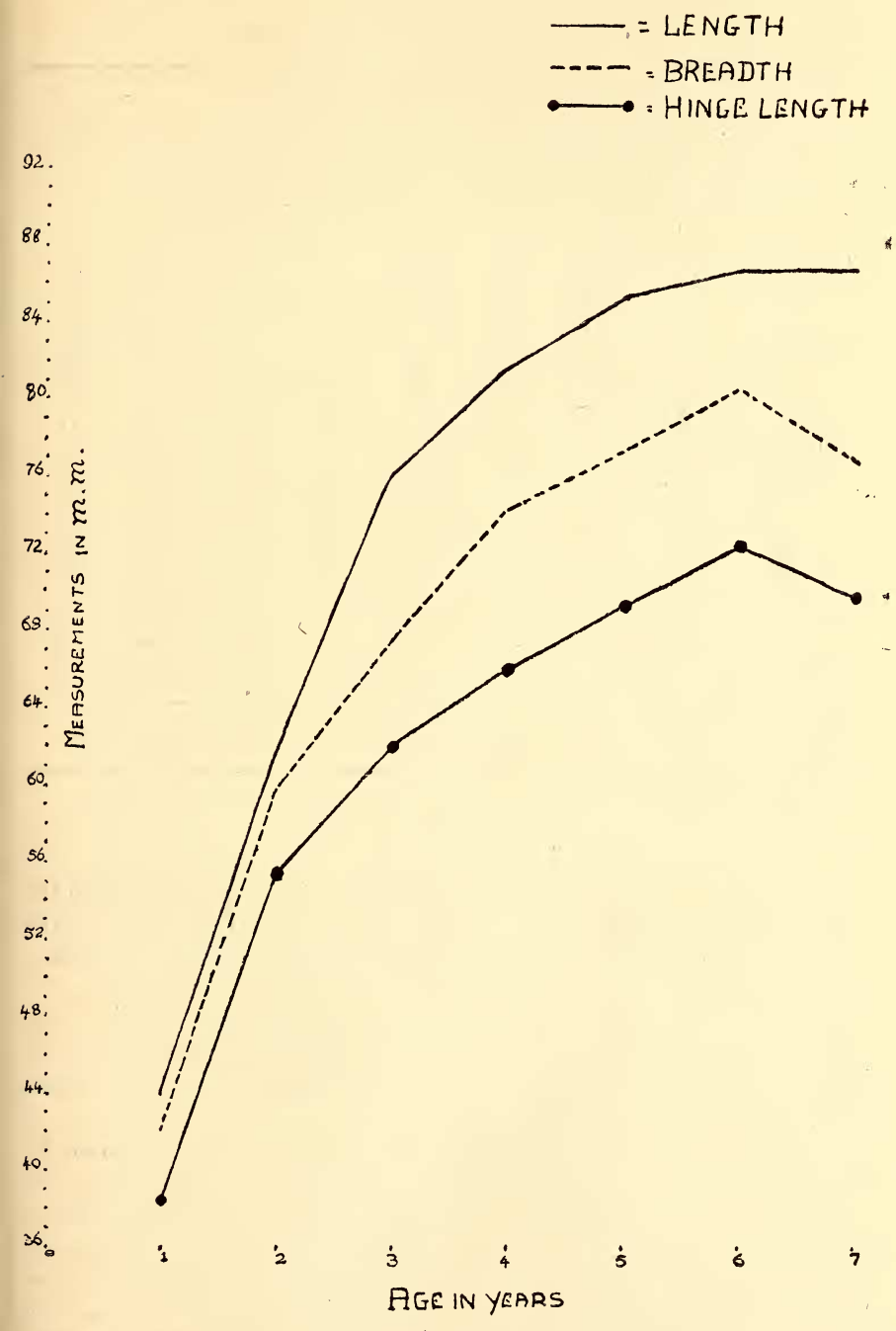
LENGTH
BREADTH
HINGE LENGTH
92
88
84
80
76
72
68
64
60
56
52
48
44
40
36
MEASUREMENTS IN M.M.
1
2
3
4
5
6
7
AGE IN YEARS

Fig. 2

TABLE 2

CORRELATION BETWEEN AGE AND THICKNESS

Thickness	Number of oysters of the age group							Total
	1	2	3	4	5	6	7	
19	11	—	—	—	—	—	—	11
20	30	—	—	—	—	—	—	30
21	64	29	—	—	—	—	—	93
22	51	60	—	—	—	—	—	111
23	15	30	26	—	—	—	—	71
24	12	15	32	—	—	—	—	59
25	9	50	41	40	—	—	—	140
26	8	12	75	41	15	—	—	151
27	2	11	51	34	16	—	—	114
28	5	7	49	32	25	—	—	118
29	—	6	30	25	19	12	—	92
30	—	—	26	24	27	15	24	116
31	—	—	15	18	28	13	12	86
32	—	—	8	8	18	9	9	52
33	—	—	1	4	15	7	16	43
34	—	—	—	—	11	6	20	37
35	—	—	—	—	6	5	13	24
36	—	—	—	—	—	5	12	17
37	—	—	—	—	—	6	9	15
38	—	—	—	—	—	4	9	13
39	—	—	—	—	—	—	7	7
Total	207	220	354	226	180	82	131	1,400

DISCUSSION

Gokhale *et al.* (1954) estimated the life span of the pearl oysters of the Gulf of Kutch as seven years, though a few individuals survive to the eighth year. According to Hornell (1922) and Cahn (1949), the Indian pearl oyster and the Japanese pearl oyster live for five and eight years respectively. We have not been able to collect oysters of the age of eight years or more, but two specimens collected from Kalumar Reef in October, 1964, had annual growth rings indicating that they were above eight years of age.

From Table 1 it is seen that the growth rate of oysters, as denoted by the increase in the length, breadth and hinge length in relation to age, is not uniform. It fluctuates and at a certain stage the growth is either retarded or stopped. The rate of variation in different age groups is also very wide. Variations in the growth rate occur within the year, as oysters grow vigorously from November to February and growth is arrested during summer. In Fig. 2, the measurements of length, breadth and hinge length are plotted against age.

Our observations show that length, breadth and hinge length are not very dependable in estimating the age of oysters, as the shell is subject to great wear and tear. In the case of thickness and hinge width, the growth rate in relation to age, is uniform and is not much affected by erosion in older shells. Figures 3 and 4 show that the thickness and hinge width are more or less proportionate to the age of the oysters and hence are more dependable.

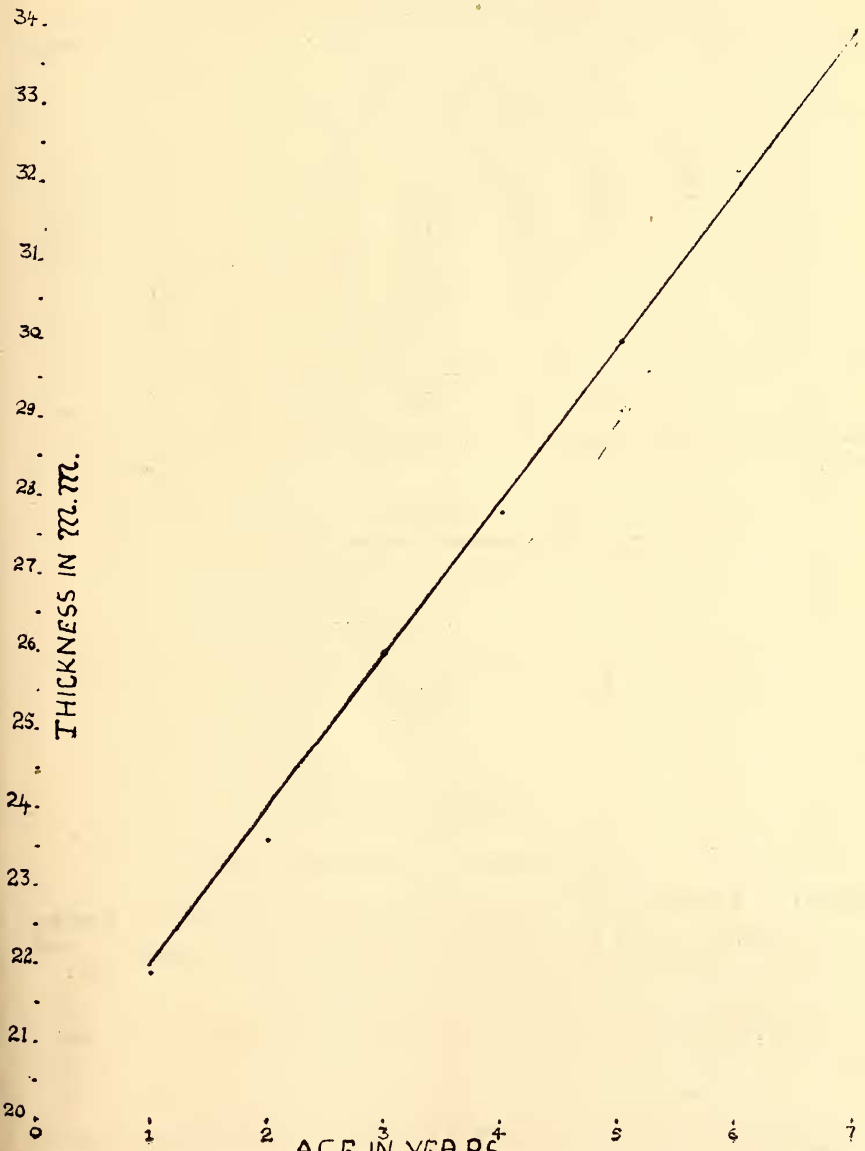

Fig. 3

Taking two points from each of the straight lines of Figures 3 and 4, an Equation of Straight Lines[1] could be arrived at, which was found to satisfy the other points of the graphs. When two points were taken

TABLE 3

CORRELATION BETWEEN AGE AND HINGE WIDTH

Hinge width	Number of oysters of the age group							Total
	1	2	3	4	5	6	7	
1	7	—	—	—	—	—	—	7
2	99	42	—	—	—	—	—	141
3	89	99	94	—	—	—	—	282
4	12	65	125	70	—	—	—	272
5	—	11	97	112	55	—	—	275
6	—	3	38	19	105	37	9	211
7	—	—	—	15	18	35	51	119
8	—	—	—	10	1	7	49	67
9	—	—	—	—	1	2	18	21
10	—	—	—	—	—	1	4	5
Total	207	220	354	226	180	82	131	1,400

[2] TABLE 4

Age	Thickness	Hinge width
1	21·9	2·50
2	23·6	3·25
3	26·0	4·20
4	27·8	5·00
5	30·0	5·80
6	32·2	6·70
7	33·8	7·66

from Fig. 2 and they were applied to the Equation of Straight Lines, it was possible to arrive at a formula, $2a + 20 = t$, where a is age in years, t thickness in millimetres and 2 and 20 constants.

[1] An equation of straight lines passing through two given points x^1, x^2, and y^1 and y^2 is $\frac{x-x^2=y-y^1}{x^2-x^1=y^2-y^1}$

[2] From Tables 2 and 3, the weighted mean of thickness and hinge width at the end of every year were calculated which are shown in Table 4.

Similarly, when two points were taken from Fig. 4 and applied to the equation, the formula was $10a + 20 = 12w$, where a is age in years, w hinge width in millimetres and 10 and 20 constants.

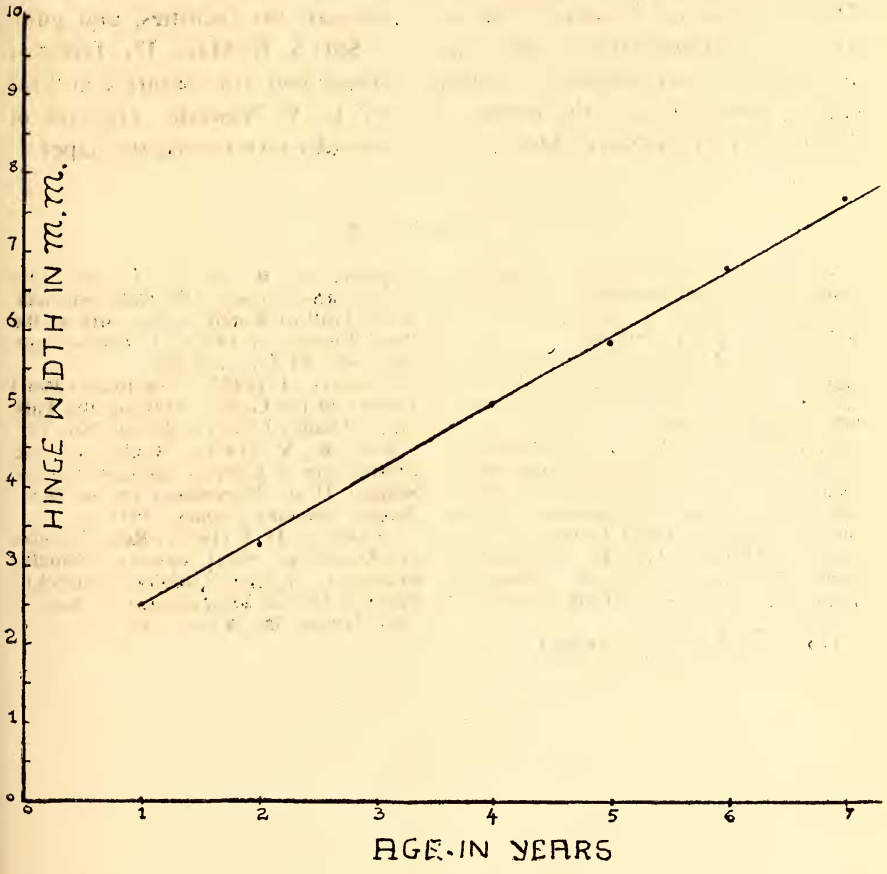

Fig. 4

Summary

1. The growth rate of the pearl oysters, as denoted by the increase in length, breadth and hinge length, is not proportionate to age. It fluctuates and is retarded after the sixth year.

2. The increase in thickness and hinge width is more or less uniform in relation to age. When the readings were plotted on graph, they gave straight lines. The equation of straight lines could be applied to these graphs and two formulae could be arrived at, one correlating age with thickness and the other age with hinge width.

3. The thickness and hinge width of pearl oysters are more dependable for estimating age of the oysters than length, breadth and hinge length.

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